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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B29D 22/00 — A1

(11) International Publication Number: WO 00/46017

(43) International Publication Date: 10 August 2000 (10.08.00)

(21) International Application Number: PCT/US00/02631

(22) International Filing Date: 2 February 2000 (02.02.00)

(30) Priority Data:
09/241,803 2 February 1999 (02.02.99) US

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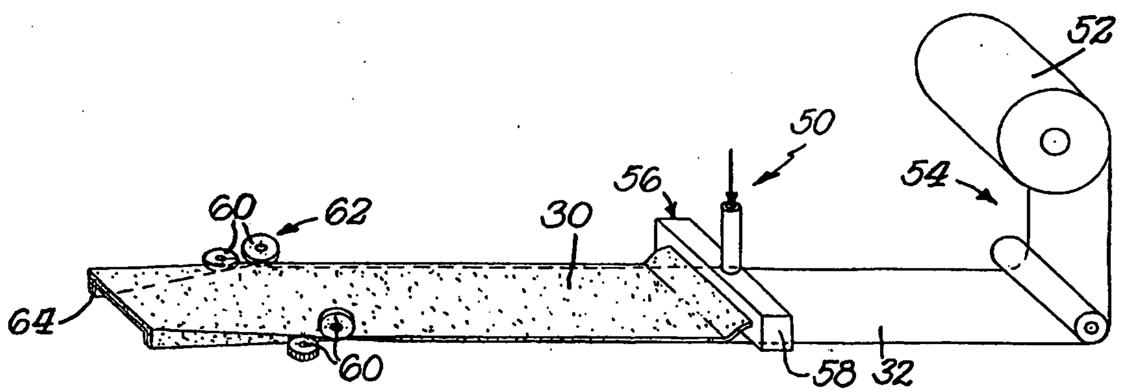
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: REINFORCED CHANNEL-SHAPED STRUCTURAL MEMBER METHODS



(57) Abstract

A part having a non-planar wall is reinforced using a preform laminate having a shape which conforms to the non-planar wall. The preform laminate is comprised of a foil or sheet carrier (32) and an outer layer of an unexpanded foam forming resin layer (30), which is inserted against the part with the resin layer disposed toward the non-planar wall. The resin layer is cured and expanded by application of heat to form a structural reinforcing foam.

REINFORCED CHANNEL-SHAPED STRUCTURAL MEMBER METHODS

TECHNICAL FIELD

The present invention relates generally to methods and apparatus for reinforcing various structures and, more specifically, relates to reinforced channel-shaped members.

BACKGROUND OF THE INVENTION

In a number of applications, light-weight, high-strength structural members are required, for example in motor vehicles and aircraft as well as in various devices such as home appliances and the like. A number of composite materials have been proposed in the past as structural members, such as exotic light-weight alloys. In most applications, however, mass reduction must be balanced against the cost of the product to the consumer. Thus, there is a need for providing strength without significantly increasing materials and labor costs. Moreover, reinforcement techniques are needed which can be adapted to existing geometries of structural parts, obviating any requirement for fundamental design changes.

As examples of reinforcement techniques, the present inventor has disclosed a number of metal/plastic composite structures for use in reinforcing motor vehicles components. In U.S. Patent No. 4,901,500, entitled "Light-weight Composite Beam," a reinforcing beam for a vehicle door is disclosed which comprises an open channel-shaped

metal member having a longitudinal cavity which is filled with a thermoset or thermoplastic resin-based material. In U.S. Patent No. 4,908,930, entitled, "Method of Making a Torsion Bar," a hollow torsion bar reinforced by a mixture of resin with filler is described. The tube is cut to length and charged with a resin-based material.

In U.S. Patent No. 4,751,249, entitled, "Reinforcement Insert for a Structural Member with Method of Making and Using the Same," a precast reinforcement insert for structural members is provided which is formed of a plurality of pellets containing a thermoset resin with a blowing agent. The precast member is expanded and cured in place in the structural member. In U.S. Patent No. 4,978, 562, entitled, "Composite Tubular Door Beam Reinforced with a Syntactic Foam Core Localized at the Mid Span of the Tube," a composite door beam is described which has a resin based core that occupies not more than one-third of the bore of a metal tube.

In U.S. Patent No. 5,575,526, entitled "Composite Laminate Beam for Automotive Body Construction," a hollow laminate beam characterized by high stiffness-to-mass ratio and having an outer portion which is separated from an inner tube by a thin layer of structural foam is described. In United States Patent No. 5,755,486, a W-shaped carrier insert reinforcement which carries a foam body is described for use in reinforcing a hollow beam.

In United States Patent Application Serial No. 08/644,389, filed May 10, 1996, entitled "INTERNAL REINFORCEMENT FOR HOLLOW STRUCTURAL ELEMENTS," (Corresponding to International Publication No. W097/43501) the present inventor discloses an I-beam reinforcement member which includes an external foam layer. The I-beam, as in the case of most of the foregoing reinforcements, involves a preformed structural insert which is then inserted into a hollow structural member.

It is also known to increase strength of a laminate structure by bonding together flat metal plates using an intervening layer of resin. For example, it is known to form a metal laminate sheet for use as a floor panel member which comprises a pair of flat metal sheets having an intervening layer of asphalt or elastic polymer.

Although filling the entirety of a section with plastic foam does significantly increase section stiffness (at least when high-density foams are utilized), this technique also may significantly increase mass and thus part weight, which, as stated, is an undesirable feature in most applications. In addition, filling a section entirely with foam may be prohibitively expensive and creates a large heat sink. And, although increasing the metal gauge of a section or adding localized metal reinforcements will increase stiffness, as the metal thickness increases, it is

more difficult to form the part due to limitations of metal forming machines.

Accordingly, it would be desirable to provide a low-cost technique for reinforcing a channel-shaped structural member without proportionately increasing the mass. It would also be desirable to provide a method of reinforcing an existing channel-shaped member which does not require any fundamental design changes to the member. The present invention provides channel-shaped members which have increased strength with moderate increases in mass and without the use of high volumes of expensive resins. The present invention further provides a method for reinforcing existing structural parts without redesigning the geometry of the part. It has been found that the present invention increases section stiffness and provides vibration dampening in channel-shaped sections in a highly efficient and reproducible manner.

SUMMARY OF THE INVENTION

In one aspect the present invention provides a reinforced channel-shaped member. The channel-shaped member is preferably a stamping or the like which defines a channel. The channel generally has a length which is greater than its width. The channel-shaped member is typically formed of metal or plastic. A layer of expanded structural foam is disposed in the channel. The shape of the structural foam matches that of the channel-shaped

stamping; that is, the foam has one surface which is bonded to and conforms to the wall of the channel-shaped member defining the channel and another (opposed) surface which is itself channel-shaped. An insert is disposed and bonded to the layer of structural foam. The insert geometry mates with that of the structural foam. The insert is a metal foil or plastic and has a thickness of from 0.002 to 0.100 inch.

In another aspect two reinforced channel shaped members are formed and are then joined together to form a reinforced tube.

In still another aspect the present invention provides a method of reinforcing a structural part which includes the steps of forming a laminated structure having a layer of unexpanded, uncured foam-forming resin ,and a layer comprising a metal or plastic carrier sheet; placing the laminate on a part having a non-planar geometry; conforming the laminate to the geometry of the non-planar part; and thermally expanding and bonding the resin to the part.

In one aspect the method of the present invention reinforces a channel-shaped structure through the steps of extruding a planar layer of thermally-expandable structural resin onto the surface of a release liner; placing a planar foil on the resin to form a foil/resin laminate having a release layer; die cutting the material to shape; removing

the release liner; placing the foil/resin laminate over a channel-shaped structural member such that the resin layer is facing the part; pressing the foil/resin laminate structure into the channel such that the resin layer contacts the part in the channel; trimming away any excess foil/resin laminate from the part; and heating the part to thermally expand the thermally expandable resin and to securely bond the resin to the foil and to the channel-shaped member.

These and other advantages and objects of the present invention will now be more fully described with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a reinforced channel member made in accordance with the present invention.

FIG. 2 is a cross section of a two layer foil/resin laminate used in the present invention.

FIG. 3 is an exploded view of the reinforced channel member of FIG. 1 in an intermediate stage of construction with the forming tool shown in position above the preform.

FIG. 4 is a cross section along lines 4-4 of FIG. 1.

FIG. 5 is a cross section of two reinforced channel shaped structures made in accordance with the

present invention welded to together at their flanges to form a reinforced tube.

FIG. 6 is a schematic perspective view of an assembly for forming laminates in accordance with one practice of this invention.

FIG. 7 is a view similar to FIG. 6 of an alternate assembly.

FIG. 7A is a perspective view of the laminate formed by the assembly of FIG. 7.

FIGS. 8-10 are cross-sectional end elevational views of alternative forms of laminates in accordance with this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to Figure 1 of the drawings, reinforced structural part 20 is shown generally having stamping 21 with walls 22 and floor or bottom 23 which define channels 24 and 26. Flanges 28 are also seen which may receive a closure plate 29 shown in phantom in Figure 4. Stamping 21 is preferably a metal stamping but could be formed by another metal forming technique such as casting or the like or could be formed of a material such as plastic, for example polycarbonate. The dimensions of stamping 21 may vary widely depending on the application. In the most preferred embodiment of the present invention, stamping 21 is a structural member, for example a radiator support structure, in a motor vehicle. Stamping 21 has a

metal gauge or thickness of from about 0.030 to about 0.120 inch.

Still referring to Figure 1 of the drawings, thermally expanded structural foam layer 30 is shown disposed on walls 22 and floor or bottom 23 in channels 24 and 26. Thermally expanded structural foam layer 30 is a structural foam that adds stiffness, strength, and vibration dampening characteristics to reinforced structural part 20. Thermally expanded structural foam layer 30 is expanded through the use of heat, as will be more fully described hereinafter and, in the expanded state depicted in Figure 1, has a thickness of from about 1/8 inch to about 3/8 inch and more preferably has a thickness of from about 3/16 inch to about 1/4 inch.

Inner reinforcement or foil 32 is seen disposed on thermally expanded structural foam layer 30 and comprises, in the most preferred embodiment, a steel foil, an aluminum foil or glass impregnated resin (Fiberglass), although it may be possible to utilize other materials in some applications. Inner reinforcement or foil 32 defines its own channel, as will be described more fully herein.

In the preferred embodiment, inner reinforcement or foil 32 is provided with a plurality of perforations 33 (shown only in Figure 3) that define perforation channels 35 (shown in Figures 3 and 4). Perforations 33 serve the important function of allowing gas to escape through inner

reinforcement or foil 32 as layer 30 thermally expands when heated. In the absence of perforations 33, thermally expanded structural foam layer 30 may not bond properly to stamping 21 due to the formation of gas pockets. Foil 32 may be in the foam of an open mesh structure which would still be capable of functioning as a carrier for foam layer 30. The open mesh structure would also provide the functioning of perforations 33.

Thermally expanded structural foam layer 30 preferably has a thickness of from about 1/8 inch to about ½ inch and more preferably, in automotive applications, a thickness of from about 1/4 inch to 3/8 inch. In most applications, thermally expanded structural foam layer 30 will extend over the entire area of foil 32; that is, it will completely separate foil 32 from stamping 21.

One important aspect of the present invention is mass reduction in reinforced structural part 20. Also, as described in the forgoing background, resin is a relatively expensive component and thus resin reduction is a desirable goal. By providing conforming or nested formed-in-place channel-shaped structures as shown in Figure 1, resin volume is reduced over a solid fill of resin and weight is reduced by using a reinforcing foil rather than a thick heavy metal, insert.

Referring now to Figure 2 of the drawings, in accordance with the method of the present invention,

laminate preform 36 is shown having thermally expandable structural resin layer 30' and inner reinforcement or foil 32' in the form of a two-layer laminate construction. The preferred method of forming laminate preform 36 is by extruding thermally expanded structural foam layer 30' onto a release paper such as a wax paper. The resin/release paper sheet is then ready to receive foil 32', i.e. foil 32' is placed on the resin side of the resin/release paper sheet. The resulting "tri-laminate" is then run through a pinch roller or the like to securely bond the resin to the foil. The procedure of forming the tri-laminate is preferably carried out using a conveyor or the like. The resin/release layer/foil sheet is then die cut to shape; the release liner is removed just prior to use. In this preferred process, thermally expandable structural resin layer 30' is at a temperature of about 100^{0}F to 150^{0}F as it is deposited on the liner.

Most preferably, foil 32' is perforated with an average of about 1 to about 2 perforations per square inch with each perforation having a diameter of about 1/16 inch to about 3/16 inch. The perforations are preformed in foil 32' prior to lamination to the resin sheet. Using the most preferred formulation for thermally expandable structural resin layer 30', laminate preform 36 can be used up to about ninety days after it is fabricated. As stated above,

laminate preform 36 (unexpanded) has a thickness of from about 1/8 inch to about 1/4 inch.

Referring now to Figure 3 of the drawings, the preferred method of conforming laminate preform 36 to stamping 21 is through the use of forming tool 38 which is shown positioned above laminate preform 36 moving in the direction of arrow A. That is, forming tool 38 contacts principal surface 40 of preform 36 and presses laminate preform 36 into channels 24 and 26. It will be appreciated then that, in essence, structural foam channel 42 and foil channel 44 are formed as best seen in Figure 4. As also best seen in Figure 4, thermally expanded structural foam layer 30 and inner reinforcement or foil 32 are trimmed to below the top surface of stamping 21.

The invention may also be practiced where the preform 36 is initially shaped to conform to its intended channel shape and thus form a drop in insert. The drop in insert could then be manually placed in the structural part 20 by an assembly line worker, rather than being pressed into the structural part by forming tool 38.

In Figure 5 of the drawings, two reinforced structural parts 20 are shown joined to form reinforced tube 46 with welded flanges 48. Thus, the present invention can also be used where tube applications are required.

A number of resin-based compositions can be utilized to form thermally expanded structural foam layer 30 in the present invention. The preferred compositions impart excellent strength and stiffness characteristics to reinforced structural part 20 while adding only marginally to the weight. With specific reference now to the composition of thermally expanded structural foam layer 30, the density of the material should preferably be from about 15 pounds per cubic feet to about 50 pounds per cubic feet to minimize weight. The melting point, heat distortion temperature and the temperature at which chemical breakdown occurs must also be sufficiently high such that thermally expanded structural foam layer 30 maintains its structure at high temperatures typically encountered in paint ovens and the like. Heat from a paint oven could be utilized to expand layer 30, rather than requiring a separate heating step not ordinarily used in vehicle manufacturing. Therefore, thermally expanded structural foam layer 30 should be able to withstand temperatures in excess of 140 degrees F. and preferably 350 degrees F. for short times without exhibiting substantial heat-induced distortion or degradation.

In more detail, in one particularly preferred embodiment thermally expanded structural foam layer 30 includes a synthetic resin, microspheres, a blowing agent and a filler. A synthetic resin comprises from about 40

percent to about 90 percent by weight, preferably from about 50 percent to about 80 percent by weight, and most preferably from about 50 percent to about 70 percent by weight of thermally expanded structural foam layer 30'. In the present invention, foam layer 30 has a cellular structure which provides a low-density, high-strength material, which, in reinforced structural part 20, provides a strong, yet lightweight structure. Microspheres which are compatible with the present invention include reinforcing "hollow" spheres or microbubbles which may be formed of either glass or plastic. Plastic microspheres may be either thermosetting or thermoplastic and either expanded or unexpanded. In one embodiment, unexpanded microspheres are used which are then expanded to form thermally expanded structural foam layer 30. The preferred microspheres are from about 10 to about 400 and preferably from about 20 to about 100 microns in diameter. The microspheres may also comprise a larger, lightweight material such as macrospheres of greater than 400 microns in diameter. Glass microspheres are particularly preferred. Also, a blowing agent is preferably included which may be either a chemical blowing agent or a physical blowing agent. The microsphere component constitutes from about 5 percent to about 50 percent by weight, preferably from about 10 percent to about 40 percent by weight, and most preferably from about 15 percent to about 40 percent by weight of the material

which forms thermally expandable structural foam layer 30'. The blowing agent constitutes from about 1 percent to about 15 percent by weight, preferably from about 1 percent to about 10 percent by weight, and most preferably from about 1 percent to about 5 percent by weight of thermally expandable structural resin layer 30'. Suitable fillers include glass or plastic microspheres, silica fume, calcium carbonate, milled glass fiber, and chopped glass strand. Glass microspheres are particularly preferred. Other materials may be suitable. A filler comprises from about 1 percent to about 40 percent by weight, preferably from about 1 percent to about 30 percent by weight and most preferably from about 1 percent to about 20 percent by weight of thermally expandable structural resin layer 30'. Preferred synthetic resins for use in the present invention include thermosets such as epoxy resins, vinyl ester resins, thermoset polyester resins, and urethane resins. It is not intended that the scope of the present invention be limited by molecular weight of the resin. Where the resin component of the liquid filler material is a thermoset resin, various accelerators, such as "EMI-24" (imidazole accelerator) and "DMP-30," and curing agents, preferably organic peroxides such as "MEK" peroxide and "Percadox," may also be included to enhance the cure rate. A functional amount of accelerator is typically from about 0.1 percent to about 4.0 percent of the resin weight with a

corresponding reduction in one of the other components. Effective amounts of processing aids, stabilizers, colorants, UV absorbers and the like may also be included in layer. Thermoplastics may also be suitable.

The following tables show preferred formulations for thermally expandable structural foam layer 30'. It has been found that these formulations provide a thermally expanded structural foam layer which fully expands and cures at about 320^{0}F and provides a reinforced structural part 20 having excellent structural properties. All percentages in the present disclosure are percent by weight unless otherwise specifically designated.

INGREDIENT	BY WEIGHT
FORMULA I	
Polyester Resin ("ARS-137-69")	80.9
"Percadox 16N"	1.1
"3M C15"	18

INGREDIENT	BY WEIGHT
FORMULA II	
EPON 828	54.5
Haloxy 62	7.5
Der 732	6.1
Expancel 5551DU	2.0
SG Micros	8.8
3M K20	17.7
DI-CY	3.4

FORMULA III	
Polyester Resin ("ARISTECH 13031")	48.8
"Percadox 16N"	0.7
"SG Micros" (PA IND)	50.5

My co-pending application Serial No.09/236,917, filed January 25, 1999, entitled Reinforced Structural Assembly discloses various types of stiffeners which are in the form of a carrier layer with a layer of polymer in which preferably, although not necessarily, includes a cover layer. All of the details of that application are incorporated herein by reference thereto. Those various stiffeners for laminated preforms may also be made in addition to the previously described laminate preform in accordance with this invention. Figures 6-7

schematically illustrate various inline assemblies for making laminate preforms. As shown in Figure 6 an inline assembly 50 includes a coil 52 which would be made of the foil or support member 32 when unwound from the coil at a supply station 54. A layer of polymer 30 is extruded onto foil 32 at extruding station 56 wherein the polymer material would be fed into extrusion die 58 having an opening corresponding to the width of foil 32 as illustrated. A suitable set of forming rollers 60 is provided downstream from the extrusion station 56 at shaping station 62. Rollers 60 bend the laminate so that the cross-section of the resultant laminate is altered from its original flat form to any suitable form such as the C or U-shaped form 64 illustrated in Figure 6. Where a cover member is to be included in the laminate, the cover member could be rolled on top of the polymer layer 30 such as downstream from the extrusion station 56 and upstream from the shaping station 62.

Figure 7 illustrates an alternative form of shaping a laminate preform. As shown therein, the assembly 70 includes a coil 52 at supply station 54 which supplies the carrier or foil 32. At extrusion station 56 the polymer layer 30 is extruded directly on foil 32 through extrusion die 58. The shaping of the final laminate preform takes place at a stamping station 72.

Stamping station 72 includes a male stamping die 74 positioned over female stamping die 76 to stamp the preform laminate 78 which is illustrated in Figure 7A. Preferably, a chilled stamping die is used at a temperature of, for example, 0° to -40°F. The chilling assists in the maintaining the part shape. Similarly, in the assembly 50 of Figure 6 the use of ambient or chilled air in the roll forming process also sets the hard shape. Where the roll forming process of Figure 6 is used, the cross section is shaped in a continuous manner and then cut to the desired length. Where the stamping die process of Figure 7 is used the part shape and length is simultaneously formed.

The coincidental forming of the polymer and carrier foil/sheet member at the same time differs from the current process which involves a separate forming of the polymer layer and support sheet and then hand placement of the polymer layer onto the support sheet.

Figures 8-10 illustrate variations of laminate preforms that could be made in accordance with this invention. Figure 8, for example, illustrates an inverted C or U-shaped form 64 having a pair of parallel legs with a generally planar intermediate section. Form 64 comprises a foil carrier 32 with a polymer layer 30 mounted completely around the carrier 32.

Figure 9 illustrates a variation wherein a pair of laminate preforms 64 is placed in abutting relationship so that the tacky polymer resin layers are secured together to form a generally I-shaped laminate 80 from the two back to back C-sections.

Figure 10 illustrates a variation where the laminate preform 82 is generally W-shaped having a foil/sheet carrier 32 with an outer polymer layer 30. Other shapes could also be formed.

It is to be understood that while the invention is intended in its preferred practices to use a foil type carrier, the carrier can be of slightly greater thickness and thus be in the nature of a sheet. The term "foil" and "sheet" are used in their normal meanings to refer to different thicknesses in that a foil is thinner than a sheet while a sheet is thinner than a plate. In its broadest practice of the invention the carrier may also be of plate thickness.

As should be apparent, the present invention could thus be used to form a wide variety of laminates which would act as effective reinforcement inserts.

What is claimed is:

1. A method of reinforcing a part, comprising the steps of:

extruding a layer of thermally expandable resin as a layer on the surface of a release liner;

placing a carrier member on said resin to form a laminate;

die cutting said laminate to a predetermined shape;

placing the laminate on a part having a non-planar geometry;

conforming the laminate to the geometry of the non-planar part;

and thermally expanding and bonding the resin to the non-planar part.

2. A method of reinforcing a part having a non-planar wall, comprising the steps of forming a reinforcing preform laminate by applying an unexpanded uncured foam forming resin layer to a carrier wherein the preform laminate has a shape which conforms to the non-planar wall, inserting the reinforcing preform laminate against the part with the resin layer disposed toward the non-planar wall between the carrier and the wall, and

curing and expanding the resin layer into bonding contact with the wall to form a structural foam which adds stiffness and strength to the part.

3. The method of reinforcing a part recited in claim 2, wherein the resin layer is heated to cure and expand the resin layer.

4. The method of reinforcing a part recited in claim 3, wherein the part is a vehicle part, and the reinforcing preform laminate is inserted as part of an assembly line operation.

5. The method of reinforcing a part recited in claim 4 wherein the resin layer is heated in a paint oven.

6. The method of reinforcing a part recited in claim 2, wherein the reinforcing preform laminate forms a lining of uniform thickness after the resin layer has been expanded.

7. The method of reinforcing a part recited in claim 2, wherein the non-planar wall is a channel having a closed end opposite an open end, and the reinforcing preform laminate is inserted into the part against the closed end.

8. The method of reinforcing a part recited in claim 7, including the step of mounting a closure plate across the open end to enclose the channel.

9. The method of reinforcing a part recited in claim 2, wherein the part is a vehicle part, and the reinforcing preform laminate is inserted into the part before the part is placed in a paint oven.

10. The method of reinforcing a part as recited in claim 2, including extruding the foam forming resin into a layer which is mounted into bonding contact with the carrier.

11. The method of reinforcing a part as recited in claim 10, including die cutting the reinforcing preform laminate into shape by a stamping die assembly.

12. The method of reinforcing a part as recited in claim 11, including chilling the stamping die assembly to set the laminate shape.

13. The method of reinforcing a part as recited in claim 10, including forming the preform to its non-planar shape by sets of forming rollers.

14. A method of forming reinforcement laminate preform in an in-line assembly comprising unwinding a layer of material from a coil at an unwinding station to form a carrier, extruding an expandable uncured foam forming resin onto and across the carrier through an extrusion die downstream from the unwinding station to form a laminate preform having a planar shape, forming

the laminate preform into a non-planar shape at a form shaping station downstream from the extrusion die, and setting the non-planar shape of the laminate preform.

15. The method of claim 14, wherein the planar laminate preform is shaped into a non-planar shape by a die stamping assembly.

16. The method of claim 15, wherein the non-planar shape is set by chilling the die stamping assembly.

17. The method of claim 14, wherein the planar laminate preform is shaped into a non-planar shape by sets of forming rollers in a roll forming step.

18. The method of claim 17, wherein the non-planar shape of the laminate preform is set by applying ambient or chilled air in the roll forming step.

19. The method of claim 14, wherein a heat expandable foam forming resin is extruded on the carrier.

20. The method of claim 14, including the step of rolling a cover layer on top of the resin before the shaping step to form a trilaminate preform.

21. The method of claim 14, wherein the non-planar shape is a C-shape formed by a pair of generally parallel legs with a generally planar intermediate section, and including the step of securing two C-sections in back to back relationship with the foam

secured together so that the resultant shape is of generally I-shape.

22. The method of claim 14, wherein the non-planar shape is of generally a W-shape.

23. The method of claim 14, wherein the non-planar shape is generally a U or C-shape having a pair of legs interconnected by an intermediate section.

24. A laminate preform drop in insert having generally a U or C-shape and having a pair of legs connected by an intermediate section, said laminate preform comprising a foil or sheet carrier and an outer unexpanded uncurved foam forming resin layer mounted on said foil or sheet carrier.

25. A laminate preform drop in insert having generally an I-shape comprised of a pair of the laminate preforms of claim 24 placed back to back in an abutting relationship.

26. A laminate preform drop in insert having generally a W-shape and comprising a foil or sheet carrier and an outer unexpanded uncured foam forming resin layer mounted on said foil or sheet carrier.

Fig. 1.

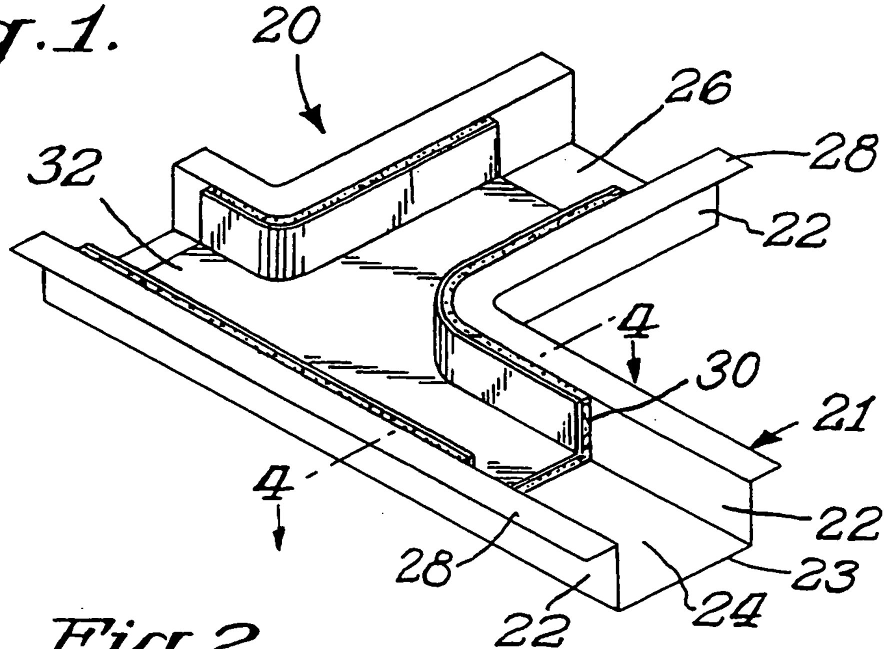


Fig. 2.

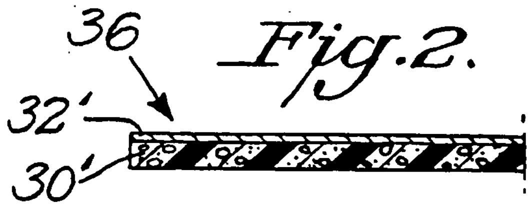


Fig. 4.

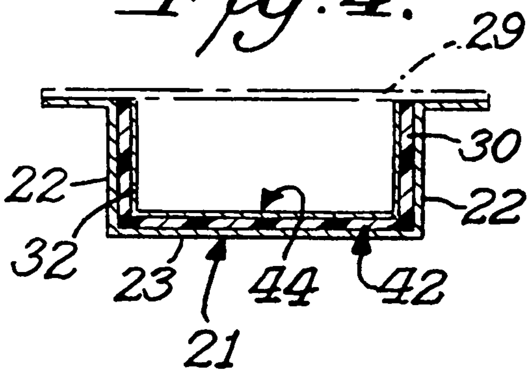
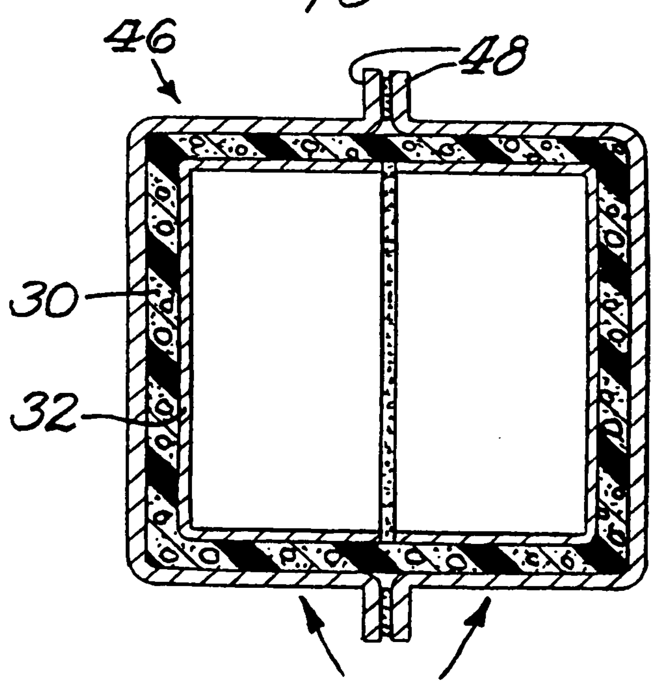


Fig. 5.



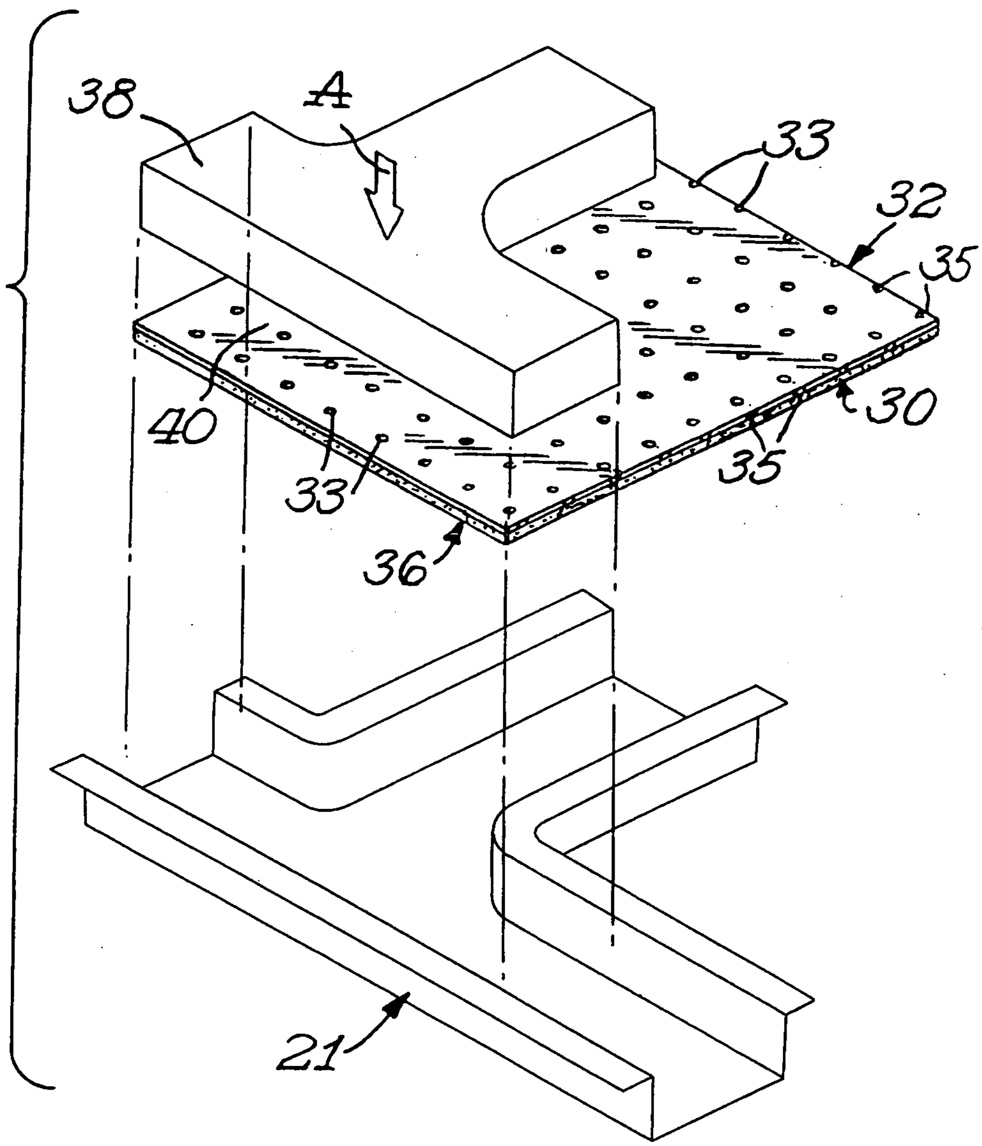


Fig.3

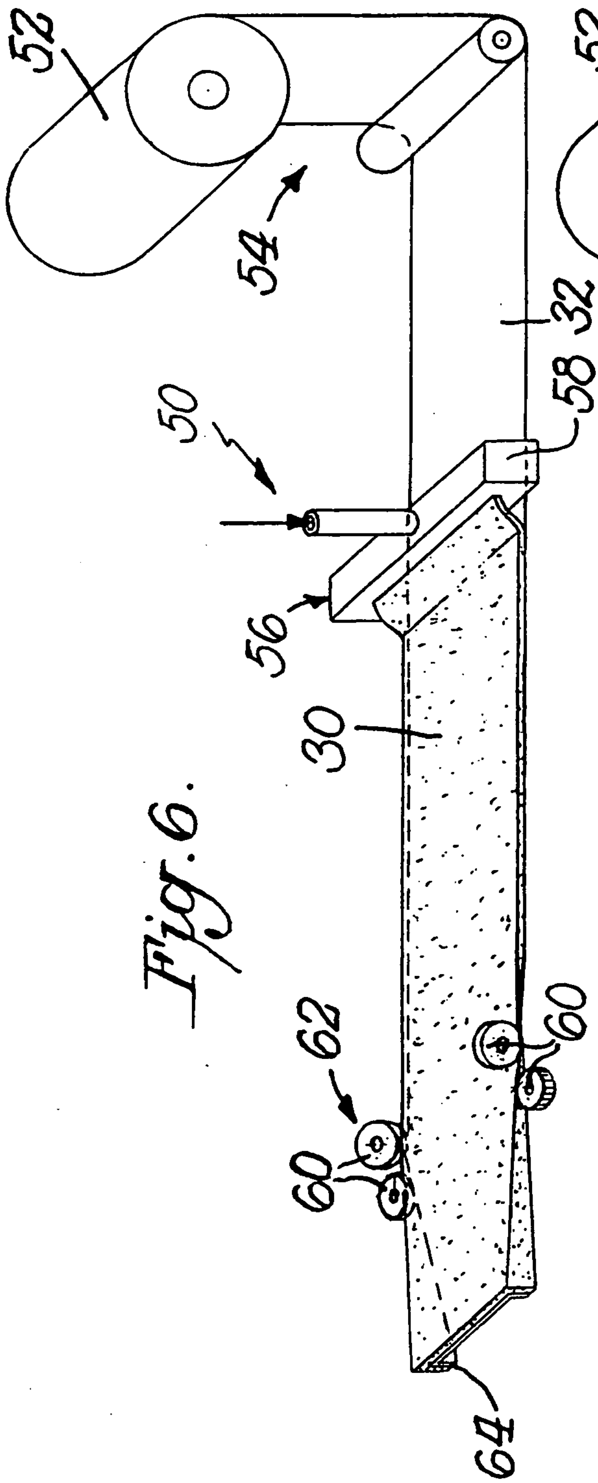


Fig. 6.

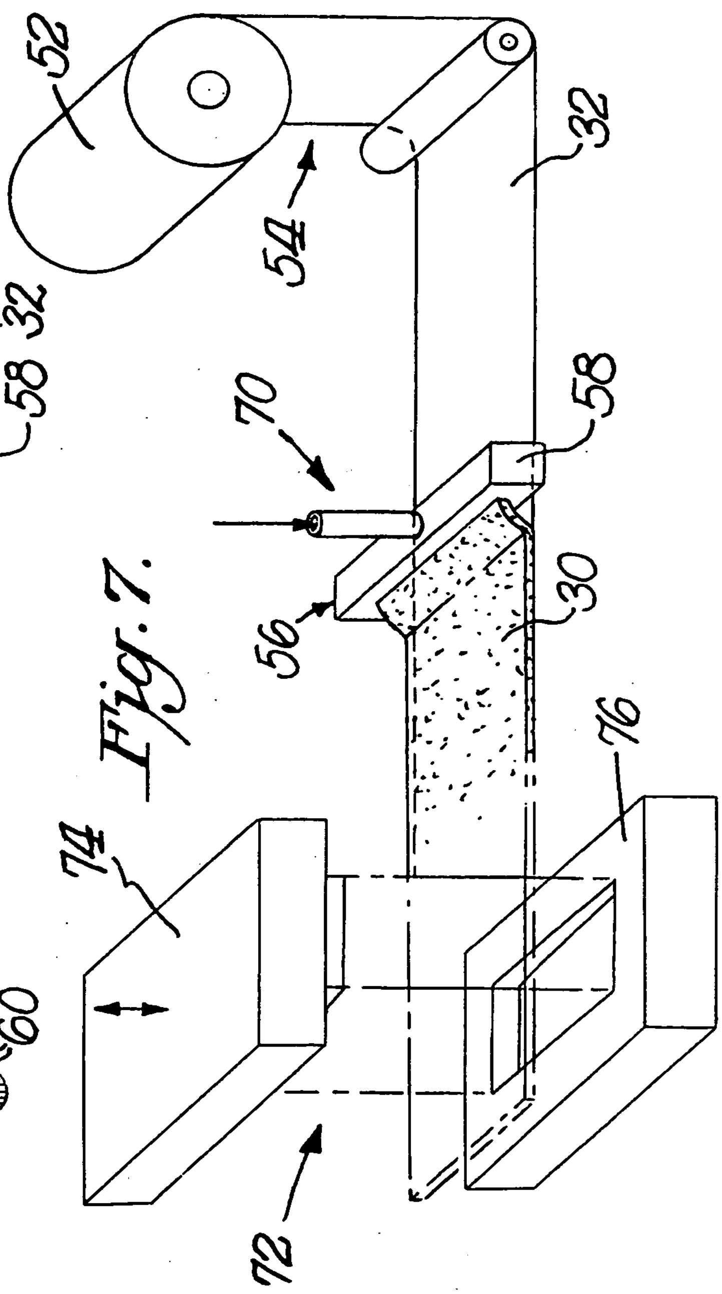


Fig. 7.

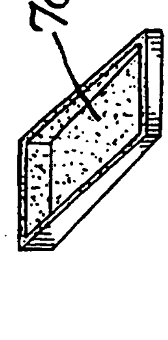


Fig. 7A.

Fig. 8.

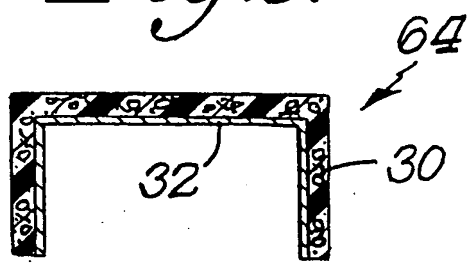


Fig. 9.

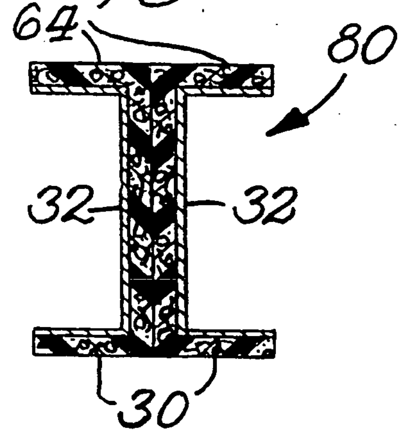
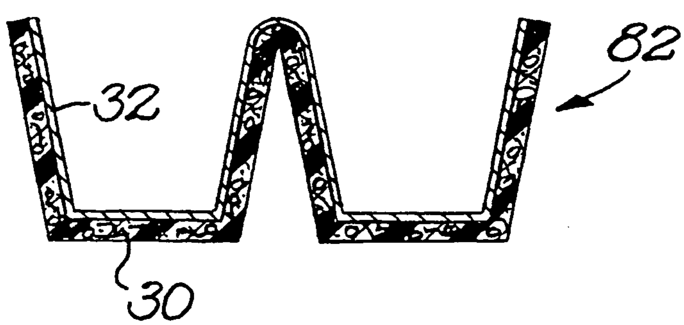


Fig. 10.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/02631

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) :B29D 22/00
US CL : 428/35.9, 36.5, 358, 613; 156/79
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 428/35.9, 36.5, 358, 613; 156/79

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,575,526 A (WYCECH) 19 November 1996	1-26
A,P	US 5,888,600 A (WYCECH) 30 March 1999	1-26

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
17 APRIL 2000

Date of mailing of the international search report
24 APR 2000

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(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 490 389 A1**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **91121384.1**

(51) Int. Cl.⁵: **B29C 67/22**

(22) Date of filing: **12.12.91**

(30) Priority: **14.12.90 JP 410946/90**

(43) Date of publication of application: **17.06.92 Bulletin 92/25**

(84) Designated Contracting States: **DE FR GB**

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(54) Stampable sheet shaped-product, process for producing the same, and use of the same as sound-absorbing and heat-insulating material.

(57) A stampable sheet shaped-product has a skin layer consisting essentially of a foamable thermosetting resin and formed on and in one or both of surfaces of a sheet-like open cell plastic foam. Optionally, a facing material layer of a proper material may be formed on one or both of surfaces of the skin layer. Such stampable sheet shaped-product is produced by applying a composition consisting essentially of a foamable thermosetting resin onto one or both of surfaces of a sheet-like open cell plastic foam, so that the one or both surfaces is or are impregnated with the composition. Optionally, placing a proper facing material on one or both of the surfaces, and subjecting the resulting material to a hot pressing. Alternatively, the stampable sheet shaped-product may be produced by a process including a thermal treatment step interposed between the above-described applying and hot-pressing steps.

EP 0 490 389 A1

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a stampable sheet shaped-product which can be shaped into various configurations and which is more lightweight than the prior art products, and a process for producing the same, as well as use of the same as a sound-absorbing and heat-insulating material.

DESCRIPTION OF THE PRIOR ART

The stampable sheet shaped-products have been used primarily as a sound-absorbing and heat-insulating material, generally in the fields of building materials, automobiles and pipings. The inventors of the present invention have proposed, in Japanese Patent Application Laid-open No.146615/87, a stampable sheet shaped-product which has a heat resistance superior to the prior art product and which is produced by hot pressing process, i.e., a stampable sheet shaped-product which is produced by applying polycarbodiimide resin to a mat-like glass fiber to given thickness and subjecting the resulting material to hot pressing.

However, when a glass mat and a felt are used in the prior art, it is necessary for the usable glass fiber to have a bulk density of 100 kg/m^3 or more and for the usable felt to have a bulk density of 300 kg/m^3 or more, for example, for the purpose of maintaining a shape required for handling in a shaping operation. Therefore, a further reduction in weight has been desired.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a stampable sheet shaped-product which is more lightweight than the prior art product, and a process for producing the same, as well as a sound-absorbing and heat-insulating material comprising such a stampable sheet shaped-product.

To achieve the above object, according to the present invention, there is provided a stampable sheet shaped-product comprising a sheet-like open cell plastic foam having a skin layer consisting essentially of a foamable thermosetting resin on one or both of surfaces.

In addition, according to the present invention, there is provided a process for producing a stampable sheet shaped-product, comprising the steps of applying a composition consisting essentially of a foamable thermosetting resin onto one or both surfaces of a sheet-like open cell plastic foam, so that the one or both surfaces is or are impregnated with the composition, and subjecting the impregnated plastic foam to hot pressing. There is also provided a process for producing a stampable sheet shaped-product, comprising the steps of applying a composition consisting essentially of a foamable thermosetting resin onto one or both surfaces of a sheet-like open cell plastic foam, so that the one or both surfaces is or are impregnated with the composition, subjecting to the impregnated plastic foam to thermal treatment, and subjecting the resulting material to hot pressing.

Further, according to the present invention, there is provided a sound-absorbing and heat insulating material comprising a stampable sheet shaped-product comprising a sheet-like open cell plastic foam having a skin layer consisting essentially of a foamable thermosetting resin on one or both of surfaces.

As used herein, the term "sound-absorbing and heat-insulating material" means a material used for sound absorption, or heat insulation or both of sound absorption and heat insulation.

The polycarbodiimide resin used in the present invention is foamable and is subjected to a shaping while being foamed. Therefore, cells in the plastic foam used as a core material cannot be closed, and the resulting shaped product has an increased sound-absorbing effect. In the prior art phenol-impregnated felt shaped-product, the heat resistance thereof is determined by the heat resistance of the phenol and there is a tendency to a reduction in heat resistance of the shaped product. However, the polycarbodiimide resin used in the present invention is a thermosetting resin which is started to be thermally decomposed at 350 °C, and a stampable sheet shaped product having an excellent heat resistance can be formed by using a heat resistant plastic foam, e.g., a melamine foam or a silicone foam as a core material. In addition, the stampable sheet shaped product of the present invention would not be burned in a normal condition. Further, the polycarbodiimide resin itself is self-extinguishing and therefore, it is possible to produce a stampable sheet shaped-product having a self-extinguishing property by integrally shaping a non-flammable or self-extinguishing plastic foam, e.g., a melamine foam or a silicone foam, or a flame-retarded facing material.

The stampable sheet shaped-product produced in this manner can be used at a place requiring a flame

retardance, e.g., a building material and an interior material; at a place requiring a heat resistance, e.g., an inner wall of an engine room or a ceiling of an automobile; or in an industrial machinery such as a motor and a generator.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described in detail.

The present invention uses a sheet-like open-cell plastic foam in place of a glass fiber which has been used for a prior art product, as described above. Examples of such sheet-like open-cell plastic foams includes open-cell plastic foams shapable by hot pressing, such as polyurethane, silicone and melamine foams. The bulk density thereof may be in a range of 8 to 100 Kg/m^3, preferably 8 to 50 Kg/m^3.

A skin layer consisting essentially of a foamable thermosetting resin is provided on and in a surface of the sheet-like open-cell plastic foam. This skin layer may be provided on one or both surfaces of the sheet-like plastic foam. As can be seen from a process for producing a stampable sheet shaped-product according to the present invention, the skin layer is formed by applying a composition consisting essentially of a foamable thermosetting resin onto the surface of the sheet-like open-cell plastic form, so that the surface of the plastic foam is impregnated with the composition, and subjecting the impregnated plastic foam to a hot pressing process. Therefore, the skin layer forms a surface layer and is deposited in a partially incorporated manner by incorporation of a portion of the skin layer into the sheet-like open-cell plastic foam.

Optionally, a facing material layer may be provided on the skin layer for the purpose of providing increases in aesthetic value, radiation effect and strength. The facing material layer may be provided on one or both surfaces of the skin layer, or may be not provided, if desired. The facing material layer may be formed from a material such as a flame-retarded polyester non-woven fabric, an aluminum foil, 20 to 50μ glass cloth, a chopped-strand mat, an aluminum deposited non-woven fabric, and the like.

An example of the foamable thermosetting resin is a polycarbodiimide resin which is described in detail in the above-described Japanese Patent Application Laid-open No.146615/87.

More specifically, the polycarbodiimide resin may be produced from one or more organic polyisocyanates, one or more cross-linking agents having two or more active hydrogen atoms in a molecule, and one or more catalysts for promoting the carbodiimidization of the isocyanates. The organic polyisocyanates include, for example, 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, crude tolylene diisocyanate, methylene diphenyl-diisocyanates and the like. The cross-linking agents having two or more active hydrogen atoms in a molecule include triazine derivatives, cyanuric acid and the derivatives thereof, hydroquinone and the like. The catalysts for promoting the carbodiimidization of the isocyanates include 1-phenyl-2-phosphorene-1-oxide, 3-methyl-2-phosphorene-1-oxide, 1-phenyl-2-phosphorene-1-sulfide and the like. Other aspects of the polycarbodiimide resin such as the ability to use a prepolymer therefor are described in detail in the above-described Japanese Patent Application Laid-open No.146615/87 and hence, the description thereof is omitted herein.

The stampable sheet-like shaped-product may be made in a process of the present invention which will be described below.

First, a composition containing an uncured foamable thermosetting resin, e.g., a solution containing an uncured polycarbodiimide resin as described above is prepared. The foamable thermosetting resin composition is applied onto one or both surfaces of the sheet-like open cell plastic foam, so that the one or both surfaces is or are impregnated with the resin. In this case, the amount of the composition containing the foamable thermosetting resin may be, for example, in a range of 50 to 500 g/m^2, preferably 100 to 350 g/m^2.

Then, the sheet-like open cell plastic foam impregnated with the foamable thermosetting resin is subjected to a hot pressing. The temperature of this hot pressing may be, for example, in a range of 150 to 250 °C, preferably 180 to 230 °C, and the time of the hot pressing may be, for example, in a range of 30 to 150 seconds. It should be noted that if the sheet-like open cell plastic foam impregnated with the foamable thermosetting resin, after placing of a facing material thereon, is subjected to a hot pressing, a stampable sheet shaped-product having a facing material layer can be provided.

In either cases, the sheet-like open cell plastic foam impregnated with the foamable thermosetting resin may be subjected to a pre-treatment (precuring) and then to a hot pressing (post-curing), if desired. In such case, conditions for the pre-treatment may be such that the temperature of the thermal treatment is in a range of 90 to 120 °C, and the time of the thermal treatment is in a range of 60 to 120 minutes.

The stampable sheet shaped-product made in the above manner according to the present invention may be subjected to a secondary fabrication in a well-known manner such as a cutting around its outer

periphery, a punching or a slitting.

The thus-obtained stampable sheet shaped product of the present invention exhibits a good sound-absorbing property and/or a heat insulating property and therefore, can be effectively used as a sound-absorbing material, a heat insulating material, or a sound-absorbing and heat-insulating material in the fields of building materials, automobiles and pipings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a side view for illustrating the production of a stampable sheet shaped-product of the present invention by pressing; and

Fig.2 is a sectional view of a shaped-product made by a producing process shown in Fig.1.

Examples

The present invention will now be described by way of examples in connection with the accompanying drawings.

Example 1

In Fig.1, reference numeral 1 indicates an open cell melamine foam which is incapable of being shaped alone, and in this Example, Basotect (Trademark) made by BASF Aktiengesellschaft was used and this foam has a bulk density of 11 kg/m^3 and a flame retardance.

An uncured foamable thermosetting resin was applied onto a surface of the melamine foam 1. The resin used in this example is a composition which will be described below (this composition is referred to as "a carbodiimide resin" hereinafter).

MDI (made by MD Kasei Co., Ltd.)	100 parts
2,4,6-triamino-1,3,5-triazine	15 parts
silicone-based surfactant	0.2 parts
3-methyl-1-phenylphosphorene oxide	0.1 parts
carbon black	0.2 parts

The polycarbodiimide resin 2 was uniformly applied onto the surface of the melamine foam 1 in an amount of 150 g/m^2 per surface, so that the surface was impregnated therewith. In Fig.1, the opposite surfaces of the melamine foam 1 were also impregnated with the polycarbodiimide resin 2, but only one surface of the melamine foam 1 may be impregnated with the polycarbodiimide resin 2.

The melamine foam 1 obtained immediately after application of the polycarbodiimide resin 2, or the melamine foam material 1 precured for 80 minutes at 100 °C immediately after application of the polycarbodiimide resin 2 can be utilized as a sheet material which has a stability for preservation for 20 to 30 days and is deformable by hot-pressing.

A polyester non-woven fabric having a weight of 50 g/m^2 was laminated as a facing material 3 onto the melamine foam material 1 deformable by hot pressing. The sheet resulting from lamination of the facing material 3 to the melamine foam material 1 was placed between an upper die 4 and a lower die 5 both heated to 200 °C and subjected to a hot pressing for 60 seconds. In this manner, one example of a stampable sheet shaped-product of the present invention shown in Fig.2 was produced by integral shaping of the melamine foam material 1 with the facing material 3 while foaming the foamable thermosetting polycarbodiimide resin 2.

The obtained stampable sheet-shaped product was subjected to a tensile test defined in JISK-6854. The result showed that the foam material was broken, and the peel-off of the facing material 3 bonded to the resin was not observed. This is because the polycarbodiimide resin 2 provides a shapability to the melamine foam 1 and at the same time, enables a bonding with the facing material 3.

In Fig.2, reference numeral 6 indicates a portion of the melamine foam 1, only the skin layer of which is impregnated with the polycarbodiimide resin 2, i.e., a portion in which the sound-absorbing and heat-insulating properties possessed by the melamine foam 1 having the same thickness as that before shaping is further improved by the foamable polycarbodiimide resin 2, and reference numeral 7 indicates a drawn portion of the melamine foam 1, i.e., a portion which exhibits a strength due to the impregnation of the entire melamine foam 1 with the polycarbodiimide resin 2 and has a thickness of 2 mm as a result of

pressing of the 20 mm thick melamine foam 1.

One example of a stampable sheet shaped-product of the present invention provided in this manner can be easily cut around its outer periphery, punched or slit. After such processing, a hydrothermal cycle test was carried out three times for the stampable sheet shaped-product, and the result showed that no variation in surface condition, rigidity and size was observed. One cycle of the hydrothermal cycle test was for 7 hours in water, for 7.5 hours at 120° C and for 7.5 hours at -30 °C.

Example 2

Stampable sheet shaped-products were produced in the same manner as in Example 1, except for the use of various amounts of the polycarbodiimide resin, various thicknesses of the melamine foam and various types of the facing materials, and were subjected to a test for estimation, together with a comparative example.

First, the following stampable sheet shaped-products A, B and C were formed by the same hot pressing for 120 seconds at 180 °C as in Example 1.

(A) A stampable sheet shaped-product (free of a facing material) having a thickness of 10 mm which was produced by applying the polycarbodiimide resin to both surfaces of the melamine foam having a bulk density of 11 kg/m^3 and a thickness of 10 mm, in an amount of 150 g/m^2 per surface and then subjecting the resulting material to a hot pressing.

(B) A stampable sheet shaped-product having a thickness of 10 mm which was produced by integrally pressing a polyester non-woven fabric having a weight of 50 g/m^2 as a facing material on both surfaces of the above stampable sheet shaped-product A.

(C) A stampable sheet shaped-product having a thickness of 10 mm which was produced by applying the polycarbodiimide resin to both surfaces of the melamine foam having a bulk density of 11 kg/m^3 and a thickness of 10 mm, in an amount of 200 g/m^2 per surface and then integrally pressing a polyester non-woven fabric having a weight of 50 g/m^2 as a facing material on both surfaces of the resulting material.

Then, a melamine foam (a) having a bulk density of 11 kg/m^3 and a thickness of 10 mm was prepared as a comparative example. The stampable sheet shaped-products A, B and C and the comparative example, i.e., the melamine foam (a) were subjected to a tensile test using a dumb-bell No.1 according to JISK-6301 to give results shown in Table 1.

Table 1

Sample No.	Elongation (%)	Tensile strength (kgf/cm^2)	Young's modulus (kgf/cm^2)
A	3.1	0.9	32.3
B	14.3	7.3	119.4
C	5.6	8.7	163.7
a	19.7	1.0	8.2

As can be seen from the results given in Table 1, the stampable sheet-shaped product A derived from the melamine foam having the both surfaces impregnated with the polycarbodiimide resin in the amount of 150 g/m^2 has an increased Young's modulus and an excellent rigidity, and the stampable sheet shaped-product B resulting from the integral pressing of the polyester non-woven fabric as a facing material has a further increased rigidity and hence, the rigidity is further improved by an increase in the amount of the resin as for the stampable sheet shaped-product C.

Example 3

The following stampable sheet shaped-products were fabricated in the same pressing process as in Example 1.

Stampable sheet shaped-products (b) made by use of a glass mat having a thickness of 8 mm

b-1 : through application of the resin in an amount of 100 g/m^2 per surface

b-2 : through application of the resin in an amount of 150 g/m^2 per surface

b-3 : through application of the resin in an amount of 200 g/m^2 per surface

Stampable sheet shaped-products (D) made by use of a melamine foam having a thickness of 8 mm

D-1 : through application of the resin in an amount of 100 g/m^2 per surface
D-2 : through application of the resin in an amount of 150 g/m^2 per surface
D-3 : through application of the resin in an amount of 200 g/m^2 per surface
Stampable sheet shaped-products (E) made by use of a soft urethane having a thickness of 8 mm
E-1 : through application of the resin in an amount of 100 g/m^2 per surface
E-2 : through application of the resin in an amount of 150 g/m^2 per surface
E-3 : through application of the resin in an amount of 200 g/m^2 per surface
Stampable sheet shaped-products (c) made by use of a glass mat having a thickness of 20 mm
c-1 : through application of the resin in an amount of 100 g/m^2 per surface
c-2 : through application of the resin in an amount of 150 g/m^2 per surface
c-3 : through application of the resin in an amount of 200 g/m^2 per surface
Stampable sheet shaped-products (F) made by use of a melamine foam having a thickness of 20 mm
F-1 : through application of the resin in an amount of 100 g/m^2 per surface
F-2 : through application of the resin in an amount of 150 g/m^2 per surface
F-3 : through application of the resin in an amount of 200 g/m^2 per surface
Stampable sheet shaped-products (G) made by use of a soft urethane having a thickness of 20 mm
G-1 : through application of the resin in an amount of 100 g/m^2 per surface
G-2 : through application of the resin in an amount of 150 g/m^2 per surface
G-3 : through application of the resin in an amount of 200 g/m^2 per surface

The glass mat, the melamine foam and the soft urethane have bulk densities of 100 kg/m^3, 11 kg/m^3 and 14 Kg/m^3, respectively, and in any of the stampable sheet shaped-products, a non-woven fabric having a weight of 50 g/m^2 was used as a facing material on both surfaces. The stampable sheet shaped-products produced in this manner were measured for the apparent specific gravity (the weight/volume of the product) and the weight. The results are given in Table 2.

Table 2

Sample No.	Apparent specific gravity (kg/m^3)	Weight (g/m^2)
b-1	139	1,110
b-2	152	1,212
b-3	165	1,318
D-1	50	400
D-2	62	496
D-3	75	598
E-1	53	418
E-2	66	512
E-3	79	613
c-1	120	2,400
c-2	131	2,620
c-3	138	2,740
F-1	27	540
F-2	31	620
F-3	37	740
G-1	30	600
G-2	34	680
G-3	40	800

Example 4

The following stampable sheet shaped-products were fabricated in the same pressing process as in Example 1.

Stampable sheet shaped-product (D-4) similar to the stampable sheet shaped-product (D-1) but with no facing material used

Stampable sheet shaped-product (F-4) similar to the stampable sheet shaped-product (F-1) but with no facing material used

Stampable sheet shaped-product (E-4) similar to the stampable sheet shaped-product (E-1) but with no facing material used

Stampable sheet shaped-product (G-4) similar to the stampable sheet shaped-product (G-1) but with no facing material used

Stampable sheet shaped-products (H) produced by use of a melamine foam having a thickness of 15 mm

H-1 : through application of the resin in an amount of 100 g/m^2 per surface

H-2 : through application of the resin in an amount of 150 g/m^2 per surface

H-3 : through application of the resin in an amount of 200 g/m^2 per surface

Sound-absorbing and heat-insulating material (d) which is a soft urethane having a thickness of 8 mm

Sound-absorbing and heat-insulating material (e) which is a soft urethane having a thickness of 20 mm

Sound-absorbing and heat-insulating material (f) which is a melamine foam having a thickness of 8 mm

Sound-absorbing and heat-insulating material (g) which is a melamine foam having a thickness of 20 mm

Sound-absorbing and heat-insulating material (h) made by use of a glass mat having a thickness of 15 mm through application of the resin in an amount of 150 g/m^2 per surface

Sound-absorbing and heat-insulating material (i) which is a felt impregnated with phenol and having a thickness of 15 mm

The glass mat, the melamine foam and the soft urethane have bulk densities of 100 kg/m^3, 11 kg/m^3 and 14 kg/m^3, respectively, and in the stampable shaped-products (H and h), a non-woven fabric having a weight of 50 g/m^2 was used as a facing material on both surfaces thereof. The thus-produced stampable shaped-products, after formation of an air layer of 10 mm on a back thereof, were measured for the direct projection sound absorbing coefficient. The results are given in Table 3.

Table 3

Frequency (Hz)	d	e	f	g	D-4	F-4	E-4
100						6.2	
125						8.1	
160						7.1	
200						8.5	
250						13.8	
315		7.7		8.4	6.2	21.7	
400	6.2	11.0	6.9	12.5	7.5	37.0	
500	6.5	13.2	8.0	16.8	14.0	39.7	
630	6.9	14.7	10.3	23.7	21.9	58.9	

800	6.9	20.0	13.2	29.5	33.4	90.6	8.8
1000	10.1	26.7	16.4	42.7	61.9	98.1	12.9
1250	11.5	34.6	19.3	51.5	83.5	91.6	16.2
1600	13.5	39.4	23.7	61.9	99.3	76.0	22.6
2000	15.1	41.5	27.0	67.7	96.1	66.4	31.6
2500	16.8	47.0	29.0	76.5	93.6	59.3	40.0
3150	28.6	57.4	44.9	83.7	81.5	49.6	61.2
4000	42.3	58.5	64.9	87.8	52.5	43.0	76.2
5000	40.3	51.7	58.6	81.3	51.3	39.7	80.0

Table 3 continued

Frequency (Hz)	G-4	h	i	H-1	H-2	H-3
100						
125					7.1	6.7
160					7.9	7.2
200			6.7	8.1	8.7	8.6
250		6.2	8.3	10.1	10.6	9.8
315	7.6	9.1	12.1	13.3	13.7	13.2
400	9.1	8.8	17.4	13.3	17.1	19.4
500	10.9	20.0	23.8	17.8	25.5	28.1
630	13.7	30.4	32.9	39.7	40.8	42.5
800	19.7	41.7	39.6	61.0	82.6	95.5
1000	29.1	58.7	60.8	82.0	92.5	76.9
1250	37.2	61.8	74.4	90.0	79.4	69.5
1600	50.5	78.6	89.0	96.9	73.0	39.6
2000	58.7	80.9	96.4	92.0	62.8	29.2
2500	72.2	86.1	98.2	74.4	38.0	20.6
3150	70.6	97.4	94.6	68.2	36.1	16.4
4000	66.2	91.9	77.8	61.8	33.4	14.1
5000	59.4	90.3	65.6	54.5	32.0	12.5

It can be seen from Table 3 that the melamine foams (f) and (g) are lightweight and excellent in sound-absorbing property. The stampable sheet shaped-products (D-4) and (F-4) of the present invention produced by use of the melamine foams (f) and (g) as a core material have a further increased sound-absorbing property. It is believed that this is because the foamable thermosetting polycarbodiimide resin providing a moldablity in the present invention was subjected to the hot pressing while being foamed, without closing the cells in the resulting plastic foam, leading to an improved sound absorbing property.

With an increase in thickness, the sound-absorption frequency region is widened and the sound absorbing property at a frequency in a range of 500 to 2,000 Hz is improved, as is the case with the common sound-absorbing material. In addition, as apparent from comparison of the stampable sheet shaped-products (H-1, H-2 and H-3) with the stampable sheet shaped-product (i), the stampable sheet shaped-products (H-1, H-2 and H-3) are higher in maximum sound-absorbing coefficient at a lower frequency than the phenol felt shaped-product (i) and the stampable shaped-product (h) produced by use of the glass mat as a core material, which are prior art products and have the same thickness.

Example 5

There were prepared the stampable sheet shaped-product (B) described in Example 2, the melamine foam having a thickness of 10 mm used as the comparative example (a) in Example 2, and the stampable sheet shaped-product (j) having a thickness of 10 mm produced by the same manner as the stampable sheet shaped-products (B) by use of the melamine foam (a) and a glass needle mat having a bulk density of 100 kg/m^3 and a thickness of 12 mm. These stampable sheet shaped-product (B) and (i) and the comparative example (a) were measured for the heat conductivity by a planar plate comparison process according to JIS A-1412, and the results are given in Table 4.

Table 4

Sample No.	Bulk density (kg/m^3)	Heat conductivity (at 10 °C) (kcal/mh°C)
(B)	50	0.027
(j)	160	0.028
(a)	11	0.028

It can be seen from Table 4 that the stampable sheet shaped-product (B) made by application of the polycarbodiimide resin to the melamine foam (a), followed by integral pressing thereof together with the facing material has heat insulating property of the open cell plastic foam used as a core material which was effectively left therein. This is because the heat-insulating effect was increased without closing of cells in the plastic foam used as a core material, in the surface of the shaped-product. It can be also seen that, as compared with the stampable sheet shaped-product (j) made by use of the glass mat having the equivalent thickness and heat conductivity, the stampable sheet shaped-product (B) has an apparent density equal to 1/3 thereof and is excellent in respect of the lightness.

Example 6

A 10 mm x 200 mm x 200 mm piece of the stampable sheet shaped-product (B) described in Example 2 and a 10 mm x 200 mm x 200 mm piece of the comparative example (a) described in Example 2 were left to stand in a drier at 150 °C for 100 hours and 200 hours and then measured for the retentions of weight and size. The results in terms of a percentage calculated with the weight and size before leaving being 100 % are give in Table 5.

Table 5

Sample No.	Retention of weight (%)		Retention of size (%)	
	after 100 hr.	after 200 hr.	after 100 hr.	after 200 hr.
(B)	97.4	96.7	99.9	99.9
(a)	88.9	88.5	97.7	97.5

As given in Table 5, any large variation in both of weight and size was not observed in a long-term heat resistance test of the stampable sheet shaped-product (B) at 150 °C.

Claims

1. A stampable sheet shaped-product comprising a sheet-like open cell plastic foam having a skin layer consisting essentially of a foamable thermosetting resin on and in one or both of surfaces.

2. A stampable sheet shaped-product according to claim 1, wherein said skin layer is bonded in a partially incorporated manner to said sheet-like open cell plastic foam.

3. A stampable sheet shaped-product according to claim 1, wherein said sheet-like open cell plastic foam is a polyurethane foam, a silicone foam, or a melamine foam.

4. A stampable sheet shaped-product according to claim 1, wherein said foamable thermosetting resin is a polycarbodiimide resin.

5. A process for producing a stampable sheet shaped-product, comprising the steps of;
applying a composition consisting essentially of a foamable thermosetting resin onto one or both of surfaces of a sheet-like open cell plastic foam, so that the one or both the surfaces is or are impregnated with the composition, and
subjecting the impregnated plastic foam to a hot pressing.

6. A process for producing a stampable sheet shaped-product, comprising the steps of;
applying a composition consisting essentially of a foamable thermosetting resin onto one or both of surfaces of a sheet-like open cell plastic foam, so that the one or both of the surfaces is or are impregnated with the composition,
subjecting to the impregnated plastic foam to a thermal treatment, and
subjecting the resulting material to a hot pressing.

7. A process for producing a stampable sheet shaped-product according to claim 5 or 6, wherein said sheet-like open cell plastic foam is a polyurethane foam, a silicone foam, or a melamine foam.

8. A stampable sheet shaped-product according to claim 5 or 6, wherein said foamable thermosetting resin is a polycarbodiimide resin.

9. A sound-absorbing and heat-insulting material comprising a sheet-like open cell plastic foam having a skin layer consisting essentially of a foamable thermosetting resin on and in one or both of surfaces.

FIG. 1

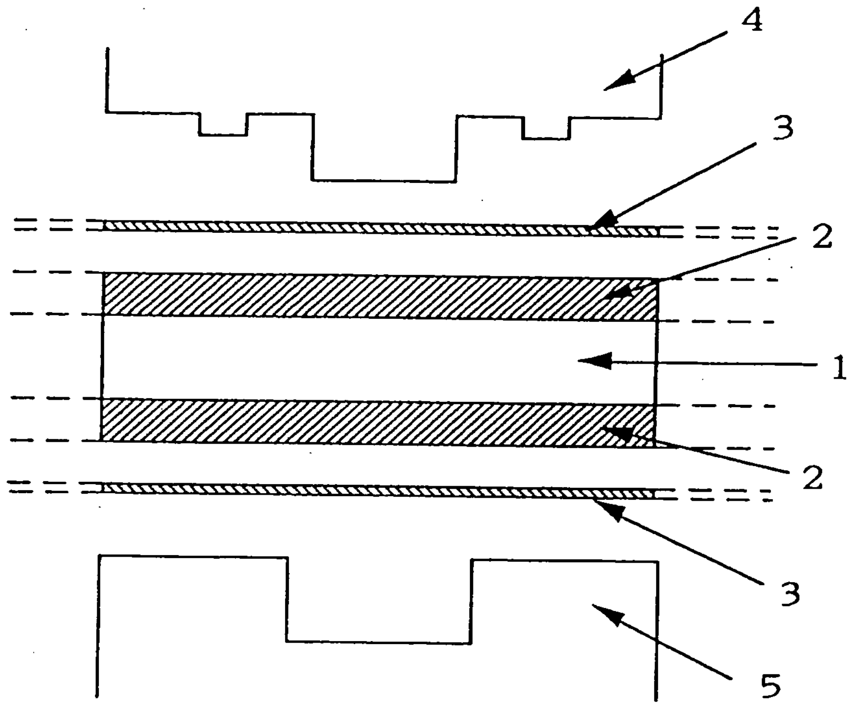
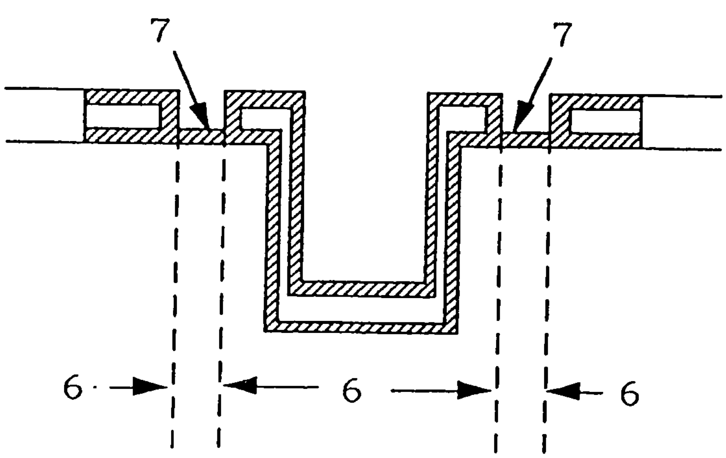


FIG. 2



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EUROPEAN SEARCH REPORT

Application Number

EP 91 12 1384

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WORLD PATENTS INDEX LATEST Derwent Publications, London, GB AN 81-390970 [22], DW8122 & JP-A-56038258 (WAKO CHEM) 13 April 1981 ---	1,2,5,7,9	B29C67/22
X	US-A-4 548 861 (J M BARNES ET AL) * column 5, line 6 - line 19 * * column 5, line 60 - column 6, line 36 * ---	1,3,5-7,9	
X	DE-A-2 915 474 (H-G RING) * page 5, paragraph 3 - page 7, paragraph 4; figures 2-4 * ---	1-3,5-7,9	
X	EP-A-0 090 959 (SCHAEFFLER TEPPICHBODEN) * the whole document * ---	1-3,5-7,9	
P,X	EP-A-0 451 535 (IRBIT RESEARCH) * page 5, line 5 - line 8 * * column 5, line 44 - line 46; claims 1-7 * ---	1-3,5-7,9	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 59 (M-199)(1204) 11 March 1983 & JP-A-57 205 125 (NIPPON TOKUSHU TORYO) 16 December 1982 * abstract * ---	1,5,6,9	B29C B32B
D,A	WORLD PATENTS INDEX LATEST Derwent Publications, London, GB AN 87-219084 [31], DW8731 & JP-A-62146615 (NISSHIN SPINNING) 30-06-87 ---	4,8	
A	DE-A-2 536 493 (BAYER) * the whole document * -----	4,8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	06 APRIL 1992	PHILPOTT G.R.

CATEGORY OF CITED DOCUMENTS

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